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Experimental Investigation on Concrete by Partially Replacement of Ware Aggregate with Junk Rubber

B.Damodhara Reddy[1], S.Aruna Jyothy[2], P.Ramesh Babu[3]

[1]*Associate Professor, Department of Civil Engineering, Sri Venkateswara College of Engineering and Technology, Chittoor, Andhra Pradesh, India.*
[2] *Assistant Professor, Department of Civil Engineering, Sri Venkateswara University College of Engineering, Tirupati, ,Andhra Pradesh, India.*
[3] *PG Student, Department of Civil Engineering, Sri Venkateswara College of Engineering and Technology, Chittoor, Andhra Pradesh, India.*

----------**ABSTRACT**----------
This experimental study is conducted to analyze the behaviour and failure characteristics of rubberized concrete where tyre rubber is partially replaced with coarse aggregate. It is estimated that more than 270 million scrap-tyres are arising each year. In India the disposal of waste tyre in landfills is a major issue handled by local municipalities and government sectors. This waste being non-biodegradable posses severe fire, environmental and health risks.Aside from tyre derived fuel,the most promising use of tyres in engineering applications as artificial reefs, erosion control and aggregates for asphalt and concrete.The use of recycled tyre rubber as partial aggregate in concrete has great potential to positively effect the properties of concrete in a wide spectrum.

Concrete is one of the most popular construction materials.Due to this fact,the construction industry is always trying to increase its uses and applications and improving its properties ,while reducing cost.The objective of this experimental study is to test the properties of concerete when recycled rubber from automotive tyres is used as a partial aggregate.Test should be taken to concrete specimens contains 10%,15% substitution of junk tyre rubber as a natural aggregate.The replacement of coarse aggregate by junk rubber in concrete has resulted in reduced compressive strengths and densities.The reductions in compressive strength and density depended on the amount of rubber added.

Keywords: CS: *compressive strength STS: split tensile strength, JRPPC: junk rubber, portland pozzolana cement.*

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I. INTRODUCTION

India has taken major initiative on developing the infrastructures such as express highways,power projects and industrial structures etc.to meet the requirements of globalization. In the construction of buildings and other structures concrete play rightful role and a large quantum of concrete is being utilized. Coarse aggregate, which is one of the constituent used in the production of conventional concrete has become highly expensive and also scarce. In the backdrop ,there is large demand for alternative materials from wastes. Waste tyre dumping or disposal of these materials causes environmental and health problems. Waste tyre management is a serious global concern. Millions of waste tyres are generated and stock piled every year, often in an uncontrolled manner,causing a major environmental problem. As tyres are durable and not naturally biodegradable ,they remain in dump sites with little degradation overtime,presenting a continuing environmental hazard. Therefore, recycling of waste materials plays a vital role in concrete.

Tyre wastes increasing anually,because now-a-days motor vehicle usage is rapidly increased. Waste tyre from vehicle is used for various process like retarding and other works etc., These type of tyres shredded to use shaped like a coarse aggregate to replace coarse aggregate partially in this process.In this scrap tyre rubber modified concrete is termed as Rubberized concrete.

The public, governments and industry are all greatly interested in green design and engineering approaches towards better environmental quality and sustainable development. At the same time, these studies can help producers to take conservative action aimed at making the environmental impact less harmful. An emerging use is the production of concrete, in which junk tyre rubber particles partially replace natural aggregates. This has the additional advantage of saving in natural aggregates used in the production of concrete which are becoming increasingly scarce. This experiment investigated a wide range of physical and mechanical properties of concrete containing recycled tyre aggregates assess its suitability as a construction material.

The influence factors such as rubber aggregate content and size, as well as curing time was also considered. The quantities of concrete produced worldwide for such applications could ensure the viability of this product. Therefore, this type of concrete shows promise for becoming an additional sustainable solution for tyre rubber waste management.

Concrete has been the most widely used construction material nearly for the period of century. Some of the peoples research the rubberized concrete : **Eldin N.N and Senouci A.B.(1993),"Rubber tyre particles as coarse aggregates"**examined compressive and tensile strengths of rubberized concrete. He notes that rubberized concrete didnot perform as well as normal concrete under repeated freeze-thaw cycles. It exhibited lower compressive and tensile strength than of normal concrete but unlike normal concrete,rubberized concrete had the ability to absorb a large amount of plastic energy under compressive and tensile loads. It didnot demonstrate the typical brittle failure,but rather ductile,plastic failure mode.

Toutanji,H.A (1996) "The use of rubber tyre particles in concrete to replace mineral aggregates" Cement concrete investigated the effect of replacement of mineral coarse aggregate by rubber tyre aggregate. Shredded rubber tyres used had a maximum size of 12.7mm and a specific gravity of about 0.61. The incorporation of these rubber tyre chips in concrete exhibited a reduction in compressive and flexural strength. The specimens which contained rubber tyre aggregate exhibited ductile failure and underwent significant displacement before fracture. The toughness of flexural specimens was evaluated for plain and rubber tyre concrete specimens. The test revealed that high toughness was displayed by specimens containing rubber tyre chips as compared to control specimens.

Khatib Z.K and Bayon F.M (1999) has developed "Rubberized portland cement concrete" to conduct experimental program in which two types of rubber fine Crumb Rubber and coarse tyre chips were used in Portland cement concrete (PCC) mixtures. Rubberized PCC mixes were developed by partially replacing the aggregate with rubber and tested for compressive and flexural strength in accordance to ASTM standards. Tyre chips were elongated particles that ranged in size from about 10 to 50mm. Results show that rubberized PCC mixes can be made and are workable to a certain degree with the tyre rubber content being as much as 57% of the total aggregate volume. However,strength results show that large reductions in strength would prohibit the use of such high rubber constant. It is suggested that rubber contents should not exceed 20% of the total aggregate volume.

Mohammed Mustafa Al Bakari. A. Syed NuzulFazl S.A, Abu Bakar M. Dand Leong K.W (2007) "Comparision of rubber as aggregate and rubber as filler in concrete" this research will attempt to use rubber waste replacement of coarse aggregates to produce early age concrete. It carry out two different type of concrete which are rubberized concrete and rubber filler in concrete. In rubberized concrete, rubbers were used to replace coarse aggregates and river sand as fine aggregate. Coarse aggregate usually gravel or crushed stone and shredded rubber as filler in concrete. The compressive strength was reduced in rubberized concrete for several reasons including the inclusion of the waste tyres rubber aggregate acted like voids in the matrix. This is because of the weak bond between the waste tyres rubber aggregate and concrete matrix. With the increase in void content of the concrete, there will be a corresponding decrease in strength. Portland cement concrete strength is dependent greatly on the coarse aggregate,density,size and hardness. Since the aggregates are partially replaced by the rubber,the reduction in strength is only natural.

Mavroulido.M and Figueiredo.J (2010) "Discarded tyre rubber as concrete aggregate: a possible outlet for used tyres" it can be concluded that despite the observed lower values of the mechanical properties of concrete there is a potential large market for concrete products in which inclusion of rubber aggregate would be feasible. These can also include non primary structural applications of the medium to low strength requirements,benefiting from other features of this type of concrete. Even if the rubber tyre aggregate was used at relatively low percentages in concrete,the amount of waste tyre rubber could be greatly reduced due to the very large market for concrete products world wide. Therefore the use of discarded tyre rubber aggregates in concrete shows promise for developing an additional route for used tyres.

II. MATERIALS AND METHODS:

Portland Pozzalana Cement of 53 grade conforming to IS: 1489-1991(Part 1) was used in this process which contain 23% fly ash. Averagely the proportion of fly ash used as Pozzolana can vary between 15% to 35% by weight of cement as stipulated by code. Coarse aggregates has been substituted by 10% and 15% of Junk tyre rubber of size vary into 12.5-20mm. A rubber covering,typically inflated or surrounding an inflated inner tube,placed around a wheel to form a soft contact with the road. Used non recyclable waste tyre is called as Junk tyres. A tyre is made up of many components which come from different sources such as plants(natural rubber), minerals(silicsa,metal reinforcements) and petroleum(synthetic elastomers,carbon black,chemicals). Approximately 4.8% of the total resources expended in the life of a car tyre used in the production stage. The simplest and most straight forward alternative to disposal is to reuse suitable tyres. In order to eliminate the environmental impact of the life cycle of a tyre,several recommendations should be carried out in each phase of the life cycle. In this study project ware aggregate is partially replaced by tyre shreds in concrete. Junk tyres collected from the Kilapulivar road,Trichy. The objective of this study is to test the properties of concrete when junk rubber from automotive tyres is used as a partial aggregate. Pre-treating the rubber with a Sodium Hydroxide (NaoH) solution modifies its surface,affecting the interfacial transition zone (ITZ) and allowing the rubber to better adhere with the Cement paste. For this study,the recycled tyres were surface-treated with a NaoH saturated aqueous solution for 20 minutes,then washed under running water and left to air dry.

PHYSICAL AND CHEMICAL PROPERTIES OF JUNK TYRES

Tyres are mostly made of rubber. Tyres are many constituent materals that go into making a tyre,the principle ingredient is indeed rubber. Tyre rubber shreds contains the following basic physical values,

PHYSICAL PROPERTIES OF JUNK TYRES

S.No	Physical property	Typical values
1	Angle of friction	19^0-26^0
2	Bulk density	350-500 kg/m
3	Compacted density	600-700 kg/m
4	Cohesion(kpa)	5-1
5	Compressibility	20-50%
6	Loose Bulk density	3.3-4.8 kN/m^3
7	Particle size	12.5 – 20mm
8	Poisson's ratio	0.2 – 0.35
9	Resilient modulus	1 – 2 Mpa
10	Specific gravity	1.09
11	Abrasion	0%
12	Water absorption	0%

CHEMICAL PROPERTIES

Tyres are complex combination of metals,minerals and hydrocarbons. Car and van tyres made of artificial rubber(styrene and butadiene). Lorry tyres mostly made of natural rubber. They made of vulcanised (cross linked polymer chains). Most commonly used tyre rubber is styrene-butadiene co-polymer- SBR containing 25% styrene. However this may be virgin rubber,synthetic rubber or recycled tyre rubber. Rubber constitutes approximately 30% of a tyre by weight with the remainder made up from other constituents including steel, nylon, rayon, carbon black, fibre glass, aramid and brass. In this process we have taken to find chemical components in the shredded pieces tyres.

CHEMICAL COMPONENTS OF JUNK TYRE RUBBER

The specific weight of the concrete modified with waste rubber reduces as the level of substitution of aggregates with tyre particles increases. This reduction can be attributed to the specific weight of tyre rubber being lower than that of traditional aggregates (1.09 for tyre rubber compared with 2.73 for coarse aggregates). However showed that the decrease in specific weight is almost negligible for rubber contents lower than 10%-20% of the total aggregate volume. The durability of a material is often related to its capacity to resist water absorption. The primary transport mechanism by which water enters cement composites is capillarity by suction. The smaller the capillarity, higher the durability of the composite. Water absorption on the tyre shreds is zero. Then it is consider reducing water cement ratio on the modified rubberized concrete.The mix proportion to be used for experimental study was arrived by doing a detailed. Concrete mix design and the method used is Indian Standards recommended method of concrere mix design IS: 10262-1982. Water cement ratio required for the target mean strength from the IS: 10262-1982 is 0.48. Nominal mix and rubberized concrete mix has prepared. Dimensions of 150*150*150mm moulds were used to prepare cubes for compressive strength tests and 150mm diameter and 300mm length cylindrical specimens were used for split tensile strength tests. Compressive ,split tensile strength was measured in concrete specimens with 10%,15% substitution of natural aggregate by junk tyre rubber shreds. The cube specimens were tested for compressive strength at the end of 3,7,14 & 28 days. The specimens stored in water were tested after drying the specimens code conforming to (IS: 516-1959). Placing a cylindrical specimen horizontally between the loading surfaces of a Univeresal testing machine carries out this test and the load is applied until failure of the cylinder, along the vertical diameter. Split tensile strength test code conforming to IS: 5816-1999.

S.NO	Name of the content	Standard value (mg/kg)	Test values (mg/kg)
1	Calcium	113-562	110.3
2	Magnesium	32-106	32
3	Zinc	8378-13494	800
4	Lead	1-160	100
5	Tin	195	196

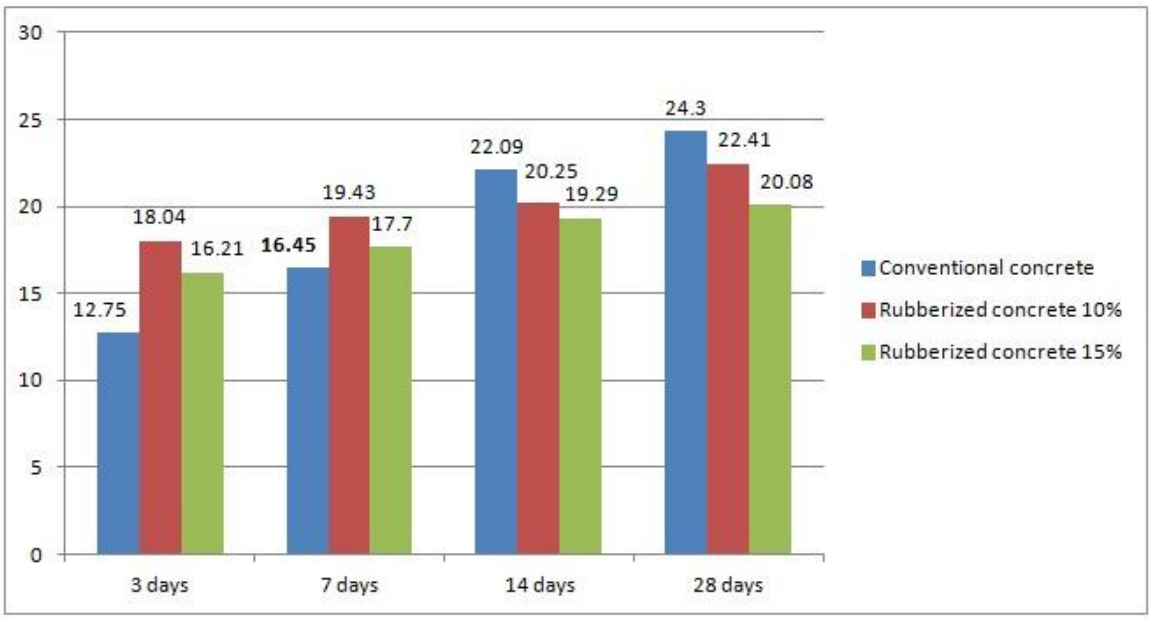
The results of the present investigation are presented both in tabular and graphical forms. In order to faciliate the analysis, interpretation of the results is carried out at each phase of the experimental work.

The interpretation of the results obtained is based on the current knowledge available in the literature as well as on the nature of results obtained. The significance of the result is assessed with reference to the standards specified by the revelant IS codes.
It also seems possible to increase the strength of concrete with rubber aggregates using various methods. These include soaking and washing rubber particles with water to remove impurities which could affect the strength of concrete. The suggested pre-treatment processess mentioned earlier are however simple and likely to be economically viable and practicable, especially if applied for precast concrete units which are produced under factory conditions. Incorporation of chemical and mineral admixtures can also be used to increase strength. Any methods of strength improvement should consider costs, as well as whether the method is practical for a larger scale concrete production as opposed to laboratory trials. Possible applications of precast concrete units with rubber aggregate include amongst other partition walls,concrete blocks for architectural applications,some cases of slabs on soil,culverts,side walks,drive ways and some road construction applications. A number of feasible non-structural concrete products including rubber aggregates can also be identified, for instance concrete fences and poles, foundation pads for machinery etc.

III. RESULTS AND DISCUSSIONS:

Compressive strength of cubes (Average results)

S.NO	Days	Conventional (N/mm^2)	Rubberized 10% (N/mm^2)	Rubberized 15% (N/mm^2)
1.	3 days	12.75	18.04	16.21
2.	7 days	16.45	19.43	17.70
3.	14 days	22.09	20.25	19.29
4.	28 days	24.30	22.41	20.08



IV. CONCLUSIONS

Utilization of waste tyres in the study process has been focus to reduce tyre wastes ,economic ,environmental management. Test results of 28 days rubberized concrete shown 10%,15% replacement of junk tyre rubber gives low compressive strength than conventional concrete specimens. Rubberized concrete gives less compressive strength is not required. Checking for rubberized concrete in non structural elements like pavements,runways,drainage,harbours etc. Rubberized concrete is also a Light Weight Concrete. Fast growing world motor vehicle usage is increasing in every year, Promisable future product for replacement of coarse aggregates. Alternative to coarse aggregate to recycle tyres helping the conservation of the environment. Reduce the natural source utilization ,improve to use modified materials, Rubberized concrete give low compressive strength which cannot be used in conventional concrete ,where as this can be used where high compressive strength not required.

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